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CLOSE OF THE AGE OF MAMMALS

BY HENRY FAIRFIELD OSBORN AND H. E. ANTHONY¹

The Age of Reptiles is estimated at 10,000,000 years by the thickness of sedimentary rocks. When the Age of Reptiles closed, land, air, and sea were left free for the rise of the mammals. The five surviving orders of reptiles were confined to the temperate and tropical zones and were only to a limited degree mammal destroyers.

The beginning of the Age of Mammals is estimated at 3,000,000 years ago. Out of very small and primitive progenitors, monotreme, marsupial, and placental, there evolved over the entire globe—land, sea, and air—a teeming mammalian life. Mammalian perfection reached its climax at the close of Pliocene time, about 400,000 years ago. The paleontologist follows this marvelous creation with wonder and admiration, as he traces the rise and adaptive radiation of twenty-four orders, one hundred sixty-six families, three thousand genera, fifteen thousand species, and its varieties of races of mammals.

The first effort at mammalian adaptation to land conditions in early Tertiary times was a failure; it was followed by natural extinction of five orders of mammals. The second mammalian adaptation culminated in the Upper Pliocene world and included man. This perfected Mammal World gradually diminished during the First, Second, and Third Glaciation, and suffered a terrible blow during the Fourth Glaciation, which led to the elimination of many superb races of mammals, and one or more of the inferior races of man. This was an extreme climatic change in which the Holarctic reindeer was driven down to

¹ This paper has been a year in preparation under the direction of the Senior author, who also contributes the introduction. The Junior author contributes the body of the paper on the fur trade, after a year of search and correspondence.

the 40th parallel, namely, 450 miles south of its present parallel. The reindeer gradually returned to northern Maine and to northern Scandinavia.

ELIMINATION BY MAN BEGAN 400,000 YEARS AGO

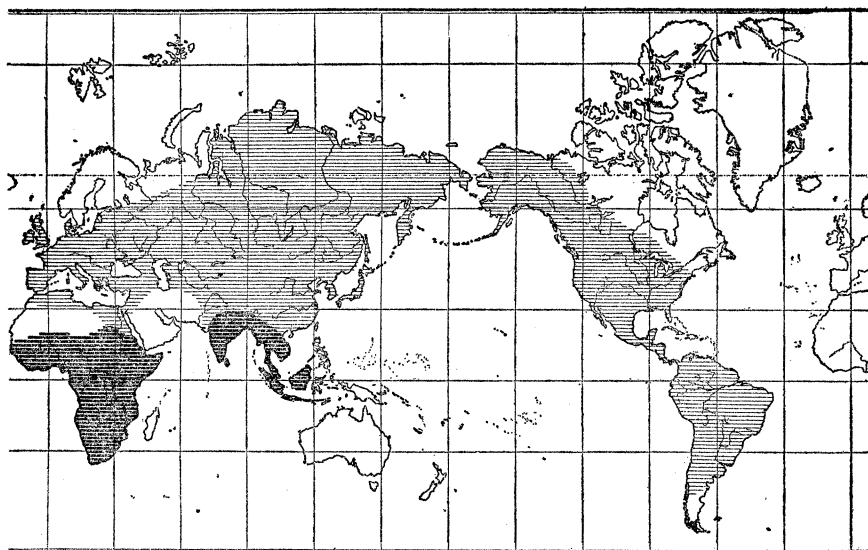
We may first review the story of civilization and extinction. In the struggle for food man sought flesh and marrow with primitive weapons of stone and wood. Man at this time was probably less destructive than most of the large predatory mammals. He killed with clubs, dug pits, rolled down rocks, etc.

The demand for clothing is very ancient, also beginning 400,000 years ago, furs and leather being utilized for clothing and footwear. The demand for bone and ivory utensils is also very ancient, the first bone tools being 40,000 years old, while the use of bone and ivory in art began between 25,000 to 30,000 years ago.

Cave men first employed light from burning animal oil and fat, and they also used fats in preparing pigments for personal decoration and in art. The demand for light culminated in the elimination of the sperm whale and other Cetacea and marine Carnivora. Five thousand five hundred whales have been taken in a single season from one whaling station in the Antarctic, and more than twelve thousand whales in a single season from the American Antarctic.

Agriculture is at least 20,000 years old. It is not known how early the value of animal compounds as fertilizers was discovered, but the *coup de grace* to marine life has been given by the fertilizer industry. In oceanic life the fate of the Cetacea and of marine mammals was sealed when the trade in spermaceti and in blubber oil was succeeded by the creation of fertilizer factories, which are rapidly eliminating the Cetacea. The other fur and hide-bearing marine Carnivora should enjoy the protection which is now being given the fur-bearing seals. The strongest appeal for the preservation of the walrus and the northern seals is the conservation of the natural food supply of the Eskimo.

Agriculture on land, the legitimate clearing of land and protecting of farms and gardens has been the next cause of elimination. The ranging of cattle and sheep over great areas, destroying winter food for game—sheep ruin whole watersheds because they devour all low vegetation and the bared hillsides have nothing to hold back melting snows for a normal gradual dissipation over the summer period—the killing of game by herd tenders, bounty systems against carnivora, and indiscriminate poisoning campaigns are all factors in the elimina-



DISTRIBUTION OF ELEPHANTS AND MASTODONS.



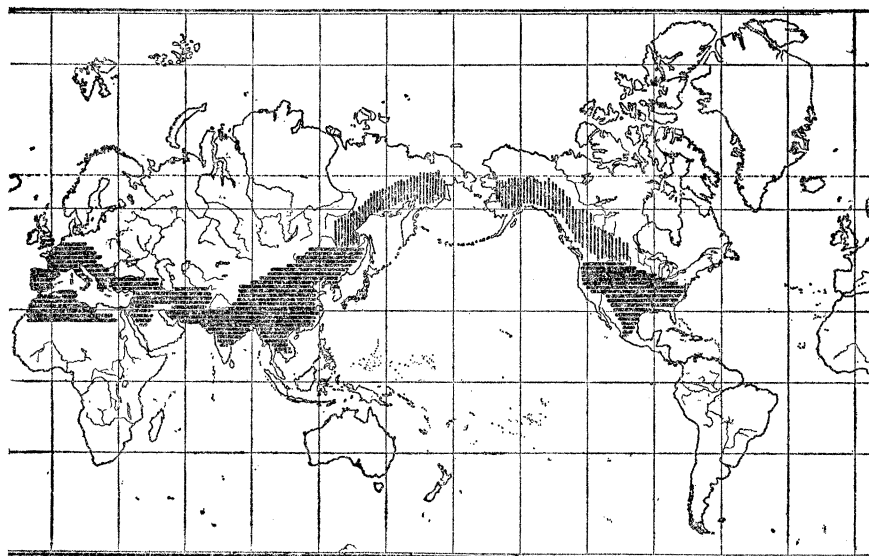
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FIG. 1

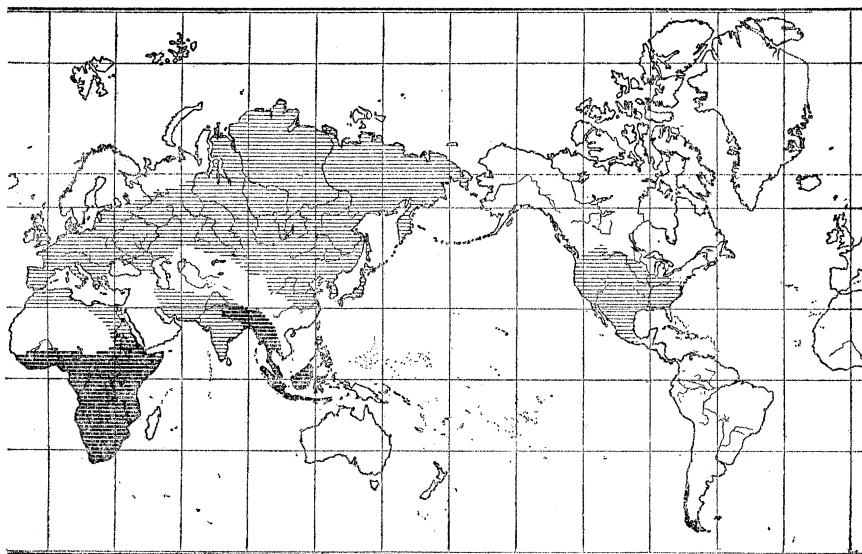



KNOWN
RANGE

KNOWN AND PROBABLE RANGE OF A SIMILAR MASTODON,
ELEPHANT, EQUINE, BOVINE, SABRE-TOOTH FAUNA IN UPPER
PLIOCENE AND LOWER PLEISTOCENE TIME.


PROBABLE
RANGE

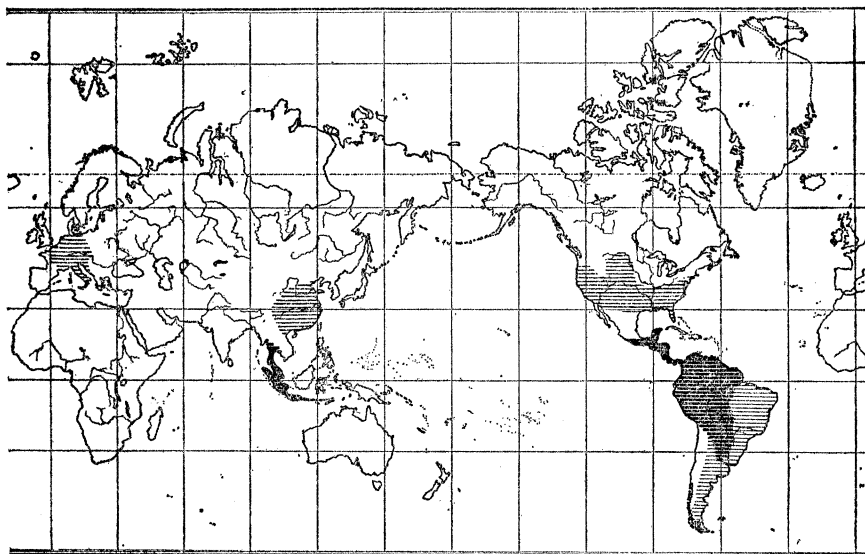
FIG. 2



DISTRIBUTION OF RHINOCEROSSES.

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FIG. 3



DISTRIBUTION OF TAPIRS.



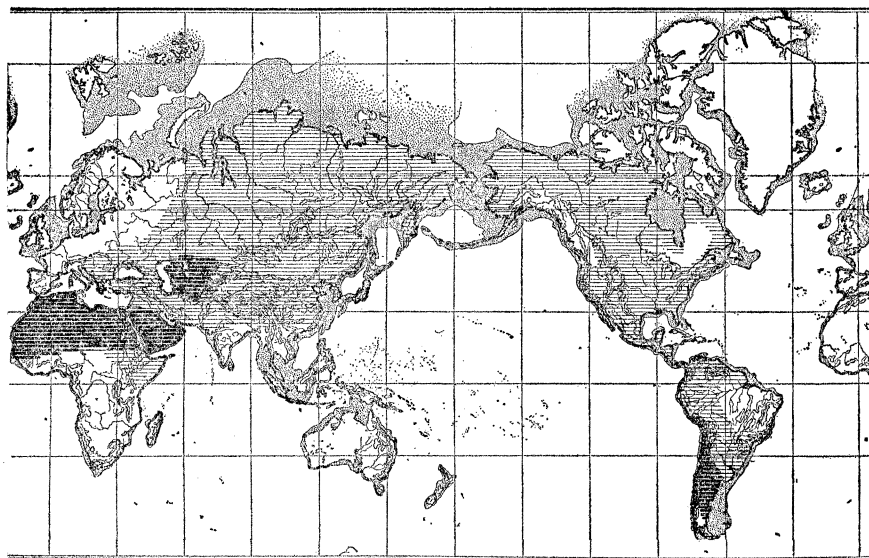
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FIG. 4



DISTRIBUTION OF CAMELS.



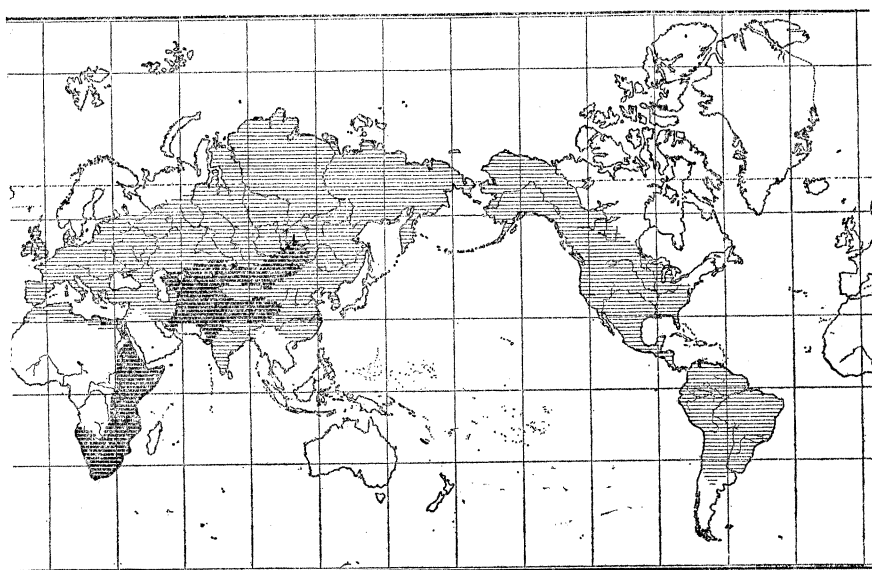
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FIG. 5



DISTRIBUTION OF HORSES, ASSES AND ZEBRAS.

Present 
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FIG. 6

tion of the mammals. Agriculture, the meat supply, and the fencing in of land is eliminating the game of Africa. Legitimate destruction by sportsmen had been comparatively a small feature. The meat market has been the chief cause of extinction of game animals throughout Alaska.

FORTY-FIVE YEARS OF PERSONAL OBSERVATION IN AMERICA

When Osborn first went to the Rocky Mountain region, as a young fossil hunter, in 1877, game animals were still universal. There was little agriculture and no barbed wire fences. Game was being killed off gradually by settlers and ranchmen, and, at times, ruthlessly by Indians. Bison were becoming scarce, but all the members of the deer family were extremely abundant and found wherever there was browse. With Sunday shooting he kept their fossil hunting camp supplied with meat—with mountain sheep, which were then in the Bad Lands, with antelope, and with black-tailed deer. Even as late as 1890, elk, deer, and antelope were extremely abundant in the uplands of Colorado. Elimination of game throughout this district is chiefly due to the winter supply of meat for ranchmen and, in a less degree, for the markets. All over the United States the legitimate meat for settlers and, to a limited degree, for the markets, has been the chief cause of elimination. Indians have come in and entirely cleaned out certain game retreats, like that of the Hell Creek region of Montana, which was full of game when Hornaday visited it in 1903.

Thus the three continents, Europe, North America, Asia, and finally Africa, have eliminated their wild animals through similar causes—the food supply, fur supply, industry and art, agriculture, deforestation, and, as a final blow but in a minor degree, sport. The number of game animals still surviving in the mountains of Asia is relatively great, but in many areas game is on the danger line.

RECENT DESTRUCTION OF FUR AND HIDE-BEARING ANIMALS

Nothing in the history of creation has paralleled the ravages of the fur and hide trade, which, with the bone fertilizer trade, now threatens the entire vertebrate kingdom. The legitimate use of furs for protection in cold weather has long since passed. Furs are now a fashion, just as feathers were thirty years ago. The trade has passed almost entirely into the hands of people of Oriental and Asiatic origin. Millions of dollars are spent annually in advertising. Furs are worn in

midsummer purely for ornament and personal adornment, or to make a display of wealth and luxury.

The final cause of the Close of the Age of Mammals can be arrested only through the creation of sound sentiment and education of the children and of women, in the same manner in which the National Association of Audubon Societies has arrested the destruction of birds. But such a movement will be extremely difficult, because the fur trade all over the world offers opportunities for money making, with very little effort and with no risk of life. Roy Chapman Andrews tells us that while he was in northern Mongolia word came through that marmot skins were coming into the market; the Mongols dropped all other work and began destroying marmots.

The best index to the destruction now going on among the mammals is afforded by a glance at the statistics of the fur trade. Anthony has compiled the figures for the years of 1919, 1920, and 1921, to show the large number of skins sold all over the country at the fur auctions, consulting a great number of fur-trade journals and reports. The best among these is the *Fur Trade Review*, a large monthly publication given over to everything of interest to the fur dealer. In the *Fur Trade Review* one can find a list of all offerings at the different fur auctions, and it may be assumed that these figures are sufficiently authentic to be used in this connection. In utilizing data of this nature, there are several features to be kept in mind. It is possible that the record of skins sold during any one year will not be a true record, inasmuch as, during a year of high prices, skins may be brought out of storage to be marketed under favorable opportunities, and in this way a large number sold during one year may have been collected over a period of several years. However, as we have had several "boom" years, it is quite likely that all of such stored skins have long since been brought out and disposed of, so that the more recent figures probably indicate animals killed within the year. Furthermore, lots of skins may be sold at the spring auction and shipped to another part of the country to be resold in the fall, consequently giving a duplication of numbers. In order to discount these figures and to keep them more conservative, we have omitted from the 1921 column the auction figures for the winter sale. This has, we believe, more than offset any duplication which may have occurred. The discounted total of all skins sold for the three years reaches the surprisingly large figure of 107,689,927 skins. Moreover, these figures indicate the slaughter of only the animals which reached the market as skins. To properly show the

slaughter that is taking place, one must allow for animals which were killed and not sent to the market because their skins were unprime, and also for a considerable percentage of wounded animals which escaped the trapper, but which, nevertheless, were killed through his agency.

	1919	1920	1921	TOTAL
Beaver, <i>Castor canadensis</i>	182, 856	122, 408	115, 226	420, 490
Muskrat, <i>Fiber zibethicus</i>	5, 821, 758	4, 651, 578	3, 635, 952	14, 109, 288
Nutria, <i>Myocastor coypu</i>	1, 125, 982	581, 978	233, 824	1, 941, 784
Squirrel, <i>Sciurus vulgaris</i>	6, 304, 777	5, 109, 181	3, 444, 358	14, 858, 316
White Hare, <i>Lepus sp?</i>	630, 720	1, 681, 838	1, 400, 478	3, 713, 036
Mole, <i>Talpa sp?</i>	6, 202, 875	8, 306, 138	9, 292, 895	23, 801, 908
Mink, <i>Putorius vison</i>	704, 148	575, 265	404, 487	1, 683, 900
Weasel or Ermine, <i>Putorius arcticus</i> .	1, 199, 901	1, 210, 726	1, 081, 785	3, 492, 412
Kolinsky, <i>Mustela sibirica</i>	379, 641	318, 724	453, 188	1, 151, 553
Skunk, <i>Mephitis sp?</i>	3, 660, 430	553, 001	2, 682, 243	6, 895, 674
Alaska fur seal, <i>Callorhinus alascanus</i>	20, 870	18, 525	45, 769	85, 164
Wolf, <i>Canis sp?</i>	370, 603	395, 371	328, 528	1, 094, 502
Red fox, <i>Vulpes fulvus</i>	348, 875	531, 433	414, 950	1, 295, 258
Silver or Black Fox, <i>Vulpes fulvus</i> . .	11, 709	7, 547	7, 094	26, 350
Civit cat, <i>Spilogale sp? Viverra sp?</i>	906, 553	601, 177	606, 805	2, 114, 535
Raccoon <i>Procyon sp?</i>	618, 382	677, 215	418, 103	1, 713, 700
Sea Otter, <i>Latax lutris</i>	15	31	30	76
American Opossum, <i>Didelphys</i> <i>virginiana</i>	2, 565, 418	3, 471, 627	3, 750, 697	9, 787, 742
Australian Opossum, <i>Phalanger sp?</i>	1, 133, 917	2, 061, 349	1, 070, 355	4, 265, 621
Ring-tail Opossum, <i>Pseudochirus and</i> <i>Phalanger</i>	282, 239	559, 649	479, 737	1, 321, 625
"Wombat" (Koala), <i>Phascolarctus</i> <i>cinereus</i>	2, 998	121, 435	84, 244	208, 677
Kangaroo, <i>Macropus sp?</i>	2, 400	16, 443	22, 395	41, 238
Wallaby, <i>Macropus sp?</i>	565, 318	693, 369	463, 901	1, 722, 588
Total	33, 042, 385	32, 266, 008	30, 437, 044	95, 745, 437

A glance at some of the noteworthy species sought by the fur trade will show something of the scope and demands of this industry. Altogether, the fur trade utilizes, at the very least, some one hundred twenty-five species, the exact number being difficult to determine because of the employment of trade names, which mean nothing to the zoologist. We have included in the table with this paper only the more important species.

The figures showing the number of beaver (*Castor canadensis*)² taken demonstrate what proper protection of a fur-bearing species may do. Formerly trapped all over the continent, beaver were brought almost to the point of extermination, but for many years they have been protected and allowed to increase unmolested; now, over a period of three years past, some 420,000 skins have come to market. The muskrat (*Fiber zibethicus*) figures indicate how relentless has been the pursuit of this small rodent, an animal which at one time brought such a low price at the sales that it was scarcely worth while to trap it. When muskrat fur came into fashion and the public demanded it, systematic campaigns of trapping began, which brought muskrat skins to the market by the millions and seriously threatened the very existence of this species. Squirrel (*Sciurus*) skins, most of which we believe have come from the Old World, make up a huge total of over fourteen million in number, and this is another example of a skin, formerly very slightly valued, coming into prominence because of the demands of fashion. Still greater numbers are shown by the mole (*Talpa*). The skin of the mole is so small that only since the interest in furs has become extreme has there been any incentive for men to molest it. Most of the skins sold at these sales must come from the Old World, and the mole, as any one knows who has tried to trap it, is an exceedingly difficult animal to capture. Over twenty-three millions of these little animals were sacrificed at the altar of the fur trade. The mole, it may be claimed, is a small, insignificant species, and here and there along the list of fur bearers are animals for which little good or economic value may be urged, but the presentation of this subject is intended to show the great destruction of mammal life irrespective of species and the desirability of the extermination of any animal does not enter into the discussion.

The mink (*Lutreola vison*), which has been one of the favorite furs in the market for many years, is an animal which apparently is nowhere to be found in very great numbers. However, since its skin has brought such a good price at auctions, the country has been combed over for mink and the annual average yield of the last three years shown has been over five hundred thousand skins. This means a very serious

² The scientific names used throughout this article are those under which the animal is best known to the general public and to the fur trade. Recently accepted changes in nomenclature have been avoided because of confusion which might arise in the minds of those who have known these animals under the older names.

tax upon the ability of the animal to maintain itself. Ermine (*Putorius arcticus*) has been worn from time immemorial and has been the fur of royalty, and no less than 4,400,000 of these little animals have come to market over the three-year period. Before the recent craze in furs had begun, the skunk (*Mephitis*) enjoyed the immunity which nature intended him to have, and his skin brought such a low figure at the auctions that it scarcely paid to run the risk of removing it. Now skunk fur commands such a high price that the trappers refuse to be balked of their prey and over six million skunk were disposed of at the auctions from 1919 to 1921. When the killing of the Alaskan fur seal (*Callorhinus alascanus*) had reached such serious proportions that the government found it necessary to take a hand, and treaties had established the right of this country to protect the fur seal, the northern herds were placed upon a basis of protection and the annual killing controlled by law. This has been found to work out most satisfactorily, and a glance at the figures shows that over the three-year period more than eighty-five thousand skins were sold—a very satisfactory total when one considers the high prices per individual skin.

The average man may be led to suppose that wolves have become almost extinct over most of the country. In the figures given for the wolf (*Canis*), there are lumped together a great many species of coyotes and wolves, but, even so, the very large total of over one million skins is very significant of the great campaign that is being carried on against this animal, and at this rate it will not be very long before the wolf is extinct indeed. The red fox (*Vulpes fulvus*) has been such a prime favorite that great numbers of his skin have come to the fur sales, and we understand that in some regions of the north the fox is virtually on the brink of extermination. Over one million two hundred thousand skins taken during the three-year period point out a rate of destruction far greater than a species like the fox can survive. On the other hand, the rarer foxes, the silver and the black, have been protected and reared in captivity, and we have learned upon good authority that most of the skins sold at the sales are those of ranch reared animals. When upwards of twenty-six thousand ranch reared skins can be sold in three years, this furnishes a significant point for the consideration of the proper methods for supplying the fur market.

The raccoon (*Procyon*) is another animal which had but little fur value in early years; but to show how his status has changed, it will only be necessary to point out a total of 1,700,000 skins for the three-year period. The sea otter (*Latax lutris*), the most beautiful of all

furs, came to the fur counters to the extent of only seventy-six specimens, and this is a sad commentary on the disappearance of this animal. Inasmuch as the animal is protected over most of its known range, some of these specimens were doubtless taken illegally, and unless some radical change for the better takes place, it will not be long before the fur dealers must do without the sea otter.

One of the most widely sold furs is one which was formerly worth but a few cents and was seldom skinned by anyone but boys. We refer to the American or Virginia opossum (*Didelphys virginiana*), which, since it has come into fashion, has been skinned to the number of 9,700,000. The Australian marsupials have known to their cost this increased demand for opossum, and the drain upon the wild life of Australia is shown by the total of over four million for the so-called "Australian opossum,"—several species of small marsupials (*Phalanger*) going under this name—a total of more than one million three hundred thousand skins for the ring-tailed opossum (*Phalanger* and *Pseudochirus*), and more than two hundred and eight thousand skins for the koala (*Phascolarctus cinereus*), or, as it is known in the fur trade, the wombat. This latter animal has a skin almost worthless, when considered from the viewpoint of beauty and durability, but the fur traders have not passed up even so poor a fur bearer.

The Australians have been anxious to conserve their wild life and have shown this in their restriction of the number of native mammals which they have allowed scientific expeditions to take, but, on the other hand, their trappers have shipped out through the principal ports literally ton upon ton of baled skins, and whole regions have been stripped of the mammal life, so that Mr. W. H. Dudley Le Souef says some of the species have been brought down so close to the danger point that a year of drought will exterminate them completely over large areas.

The figures just cited give a little insight into what the fur trade is doing toward bringing about the Close of the Age of Mammals. In a few years some of the mammals now sought by the trappers will be killed off to a point where they will not repay trapping—the numbers taken being insufficient to repay for the expenditure of energy. Mammals are frequently subject to the attacks of different parasites, and are very susceptible to the spread of different epidemics. When the balance of nature has been disturbed and a species is brought to the point where the struggle for existence is precarious, it may happen that a species will disappear completely; in other words, be exterminated

by the appearance of some natural factor which it has been amply able to resist before its numbers were depleted by the demands of the furriers.

In Africa a number of animals have reached this point. Some of them have been killed off by natural causes, and others by the development of agriculture and by firearms in the hands of natives. In Africa epidemics appear to have unusually favorable facilities for spreading and many of the ungulates are standing upon the brink of disappearance. Mr. Herbert Lang has given us the names of the more important of the African mammals which have either disappeared or are about to disappear. We mention the quagga and the blaubok, which have disappeared completely, while the mountain zebra, the bontebuck, the white rhinoceros, the okapi, the black wildebeest, the greater kudu, and the elephants of the Addo Bush are about to join them. The elephants of the Addo Bush are being systematically exterminated under government supervision, and the story of their downfall has been given in Hamlyn's *Menagerie Magazine*.

The center of the fur trade has passed over to this country. Before the war London was the world's fur market, but it now appears that the control has definitely passed over to the United States, and the great market of the present day is here with us. The figures given out by the Fur Dressers and the Fur Dyers Association show that in New York alone over eighty million skins were dressed and over ninety-seven million were dyed by the members of this association for the years 1918, 1919, and 1920. Thus it would appear that the heart of this industry beats in our own country, and if there is to be any prescription written, the initiative should be taken by us. The fur dealers themselves, for the most part, seem to realize that the wild animals are an asset of their industry, and judging by the editorials of the different journals, and the articles that appear, we believe that the majority of them, if the matter were put to a vote, would encourage a better method of trapping and a more extended control over the wild animal supply. It would suit their own purposes better if animals could be taken only during that part of the winter when they were prime; and the restriction of the hunting period to such a time of the year would be an important first step toward the conservation of fur bearers. But as matters now stand, when fur prices begin to mount to such figures that a few skins represent many dollars, then in the out of way places where laws have little significance at any time, men go out and kill every fur bearer that may come to hand, and run out their traps for whatever they may catch.

Therefore, we believe that if some more drastic methods of checking this perfectly appalling slaughter are not soon inaugurated, the fur industry will have been the means of quite definitely closing the Age of Mammals insofar as it applies to a number of species.

DISCUSSION BY PROMINENT MAMMALOGISTS

At the conclusion of the paper, Dr. W. T. Hornaday, director of the New York Zoological Park, who is the foremost advocate of wild life protection in the world, arose and commented on this joint paper. He began his remarks by stating that he thought Professor Osborn was entirely within bounds in saying that we were at the close of the Age of Mammals; that to his mind there was nothing more terrible to contemplate at this time than the grinding and devastating power of modern civilization as it is exerted, not only on animal life generally, but on vegetable life and on all the products of nature; that the human race is increasing and spreading, and it is also increasing in its power and ingenuity to destroy. The Zoological Society receives reports and communications from a great many far-distant portions of the world, where there is today the greatest abundance of animal life, and the story that is told by that correspondence everywhere is the same. It is the story of the continuous and alarming disappearance of the most important wild animal forms.

Taking Africa as an example, Doctor Hornaday said that a new influence has been brought to bear on the wild life of British East Africa, and of South Africa for that matter. The British government has been sending to British East Africa a great many ex-service men. They have been located there on farms, where they practically subsist on the resources of the country, living, to a great extent, on the game. Many of them are killing game wantonly, which they are well equipped to do, and none of them, he thinks, are preserving game. He stated that the Zoological Society had received most alarming reports from South Africa and from the Egyptian Soudan, and he continued as follows: "We are in close touch with men in the Union of South Africa, who are deeply interested in preserving the remnants of Africa's magnificent mammalian fauna and who will do all they can, under the tremendous handicaps that are upon them, to stem the tide of destruction. We have been called upon for practical assistance and the Permanent Wild Life Protection Fund is now on the point of sounding an alarm gong throughout South Africa, chiefly for the purpose of attempting to arouse the people of South Africa to the danger that besets their best, most interesting, and most vital wild life. Mr. Anthony has named to you a number of important species in South Africa that are threatened. It is no exaggeration to say that the kudu, the white rhinoceros, of course, and many others that could be named, are on the point of total destruction. Here in the United States we are engaged in a hard to hand struggle to save the pronghorn antelope from going down and out as a species, in spite of our efforts, and literally before our eyes. I think that there never has been an American species which has been so persistent in getting on the toboggan slide of its own accord as the pronghorn antelope. It is delicate in body. It is easily exterminated in the wild state, and now every tendency of civilization is to destroy it."

Doctor Hornaday then discussed the efforts of the American Bison Society to save the remnants. Taking the case of the state of Wyoming, he stated that the governor of Wyoming had said that the antelope is being destroyed by the homesteaders who have gone in there — in some instances having been induced to go in when they should not have gone — to locate on semi-arid lands; that in trying to live without irrigation and without any resources what ever of their own, and being hard pressed for food, they are killing the antelope and every other wild animal that they can reach; that there is no way of stopping it, there are so many of them that the state could not put in enough game wardens to prevent them from killing the animals. The governor is so thoroughly alarmed that he is now proposing a special state game preserve for the antelope. Doctor Hornaday believes that the handicaps on the antelope and the handicaps on those who will try to save it are so numerous and so great that the antelope is doomed to go down and out in about twenty-five years. The trouble is, when the antelope seems to be doing the best, something comes along and, in a twinkling, all is changed for the worse.

He stated that in far-distant countries, inhabited by savage tribes, it is now a lamentable fact that the natives are acquiring modern firearms. In India, forty years ago, the natives were not permitted by the Government to have firearms or to hunt with them. Now they have just as good breech-loading rifles as the English sportsmen, and they are using them very generally, and the English sportsmen say the game in India is being rapidly annihilated.

Doctor Hornaday continued as follows: "We must think in decades, quarter-centuries, half-centuries, and centuries. Geologic time is not for us. We are approaching the complete destruction of our wild life at express speed, and the rapidity with which the fauna and the best wild life of the world, that is, the mammal life of the world, is being destroyed, is ground for the most gloomy foreboding and confirmed pessimism. There are many far-sighted men and women who are doing their utmost to stem this tide of destruction and to save the depleted remnants for posterity. But what does it amount to? We may as well face these facts like men. We should not deceive ourselves. As a matter of fact, for every person who is putting forth active efforts to preserve the mammal life of the world, there are from one thousand to ten thousand, or even a hundred thousand destroyers. I have been devoting some thought recently to that subject. In the state of New York we have figures available. I have figured it out that in New York state, for every person who is actively engaged in preserving the mammal and bird life of the state, there are five hundred destroyers. In the West I think the number will be 1 to 1000; in Alaska I think it is about 1 to 2000; that is to say, for every person who is laboring to preserve the wild life, there are 2000 destroyers. In Africa, what shall we say? I should imagine that for every person on the continent of Africa who is attempting actively to preserve wild life there are 100,000 persons destroying it. We know that the great game preserves that are being created and protected at such great expense by the nation, by the states, by private individuals, and by a few other countries, will do something toward preserving some of these species from total extinction."

Doctor Hornaday stated that there are thoughtful men, of whom Mr. Madison Grant is one, who believe now, and have believed for some years, that a time will soon come when there will be no big game remaining in the United States or on the

continent of North America, save in the patrolled game preserves, and that he was fully convinced that this is true, and the only thing that is questionable about it is the number of years that will elapse before this is actually the state of affairs.

Doctor Hornaday believes we must not be discouraged in our efforts to preserve the remnants of the once glorious mammalian fauna. It is our duty to fight for it as long as we live. The close of the Age of Mammals may be ever so certain, but we have a right to hope that somehow and somewhere, in various places, fortune will favor our efforts. He said that the fur trade was doing its utmost to destroy everything that by any stretch of the imagination can be regarded as fur; that the destruction of the life of fur bearers has reached such a state that it is simply disgusting, and that there is no animal too mean or malodorous to be used by the fur trade.

Doctor Hornaday concluded by saying that he had far exceeded the time he had intended to speak, and that he closed as he began, by expressing his firm conviction that Professor Osborn and Mr. Anthony were absolutely right in saying that we are at the close of the Age of Mammals.

Dr. William Diller Matthew, chief of the Division of Geology and Palæontology of the American Museum, who has made a commanding study of the life of animals of the past and the natural causes of extinction, was then called upon to discuss the paper, and remarked, that, to his mind, the distributional maps that Professor Osborn had shown and the statistics that Mr. Anthony had placed before the meeting told the story of the disappearance of the great animals very impressively, and demonstrated one of the principal causes, at all events, for their disappearance. He said: "I do not think that one can fail to be fully convinced from these maps and figures. I think, however, that the maps and figures have underestimated the facts, if anything, as to the former great abundance and variety of animal life, and especially of the large animals. It is to be remembered that those comparisons are based only upon such types as have been found. There are many records of fossils in various parts of the world; but at the same time we are far from having explored any part of the earth's surface thoroughly. There is no country in the world in which, during the last few years, explorers have failed to discover many new extinct types that have been wholly unknown; and skulls or skeletons of other types that have either been slightly known from small fragments, or have been regarded as animals having no real existence, merely products of the scientist's imagination or the itch for species making. In half a century from now we will look back at our present knowledge of the Pleistocene and Pliocene life of the world with the same amusement with which we read in the older textbooks the large words that cloaked the ignorance of fifty years ago. The plain fact is that we know very little, even yet, of the great varied mammalian fauna that inhabited the six continents at the end of the Age of Mammals.

Doctor Hornaday has shown the impending extinction—and extinction that seems almost unavoidable—of the pronghorn antelope. It is an animal that for various reasons we believe must be a solitary survivor of what was formerly a more abundant and varied group of animals. We have had no real evidence of that until comparatively recent years. We have at present three extinct relatives of the pronghorn antelope recorded. In the course of discovery of the next

half-century we may develop as large a variety of pronghorns and their relatives in this country as we have of true antelopes in the Old World.

I have given this instance of the pronghorn antelope simply to show that the Pleistocene and Pliocene mammal faunæ were really of great richness and variety, and it is, therefore, no exaggeration to state that there has been a very great reduction in the mammal fauna when we pass down to the mammals of today.

Dr. W. H. Osgood of the Field Museum of Natural History was then called upon and after agreeing with previous speakers, contributed a few further remarks to the discussion, giving his own impressions as to the contrast between conditions in settled regions and what one finds in going to those which have been practically uninfluenced by the forces of modern civilization. He stated that this had been his privilege upon one or two occasions in South America, where he had happened to penetrate into some of the few regions where Indians are still hostile and where conditions and surroundings might be said to be almost as they have been from the beginning. He had been particularly impressed in these regions with the very great abundance of animal life of all sorts, and especially of those kinds upon which man might be said to prey. Birds of large size, as ducks and gallinaceous birds, were found in such places to be as abundant as they were in this country when it was first settled, and he thought that this could also be truthfully stated about the members of the deer family and other groups of mammals. Such experiences bring an acute realization of the rapid changes that are taking place.

Dr. Charles C. Adams of the Roosevelt Wild Life Experiment Station, at Syracuse, added the following comments upon the Close of the Age of Mammals: He regretted the terrific destruction which was going on and stated that conditions surely demanded improvement. His solution of the difficulty would be to use the forces of education and the widespread use of preserves making these the main means to help stem the tide. This education should not be content to deal only with adults, because unless it began before maturity—with the younger generation—it would be useless. And neither did he think that such education could be limited to the Audubon Society, which is a specialized society for birds. There is an urgent need, he said, of an organization upon a conservation basis that will begin at the bottom and cover thoroughly the whole field. And this means also that the idea of preserves must be developed on a very large scale. Doctor Adams believed that the preserve idea is a most constructive feature, especially if some of the federal land be segregated and administered by the Central Government supplementing the National Parks and National Forests. The carrying out of this idea would mean an increase of our state parks and forests on a plan hardly dreamed of at the present time. Not only is there a call for large game preserves, but small game preserves and wild life or natural history sanctuaries must be established, since the purpose of education would not be served by a few large preserves which would be at a distance from the larger part of the population. The preserves must be so located that people may be taught the conservation of wild life near at home.

Another point that Doctor Adams brought out is the necessity for learning more of the life habits of the mammals; as a necessary condition for their intelli-

gent preservation and public appreciation. It would be only a partial remedy to establish preserves unless we know more about the habits of the mammals which we hope to protect in these preserves, and it is highly essential that more attention be paid to this intimate detailed knowledge of life history and ecology of our mammalian fauna. It is this aspect of natural history that has the greatest popular appeal and is most intimately related to economic problems.

He believed that men are coming to realize more and more the threatening features of the destruction of mammal life. There seems to be a feeling that opposition to this destruction is almost hopeless; that there is no use trying to stem the tide. While Doctor Adams granted that the problem is sufficiently discouraging, he regarded it in the same light as he did the question of our liberty, in the best sense of the term. Our liberty or our opportunities for living is a thing to be protected at any price, and the struggle for its protection must not be relinquished at any time. We cannot save wild life unless we go about it with the same earnestness and with the same refusal to acknowledge defeat that we would employ in the protection and conservation of our liberty. It is a similar unending process of adjustment to our conditions of life.

The discussion was brought to a close by the comments of Dr. E. W. Nelson, chief of the Biological Survey of the United States Department of Agriculture, charged with the Federal activities in relation to game and other mammal life. Doctor Nelson stated that the Biological Survey is engaged largely in the work of conservation and he has been more and more impressed, especially during the last few years, with the difficulties, and in some instances the apparently insurmountable difficulties, in the way of saving any considerable share of the existing large mammals of the world.

The rapid progress of modern civilization of man has accelerated the downhill procession of the other important mammals. Primitive man was simply one of the various predatory animals which preyed upon the coexistent animal life. At that stage man, like other mammals, was subject to the vicissitudes of his environment. Diseases or severe drouths or other inclement climatic conditions and other causes which destroyed wild life in general also destroyed a similar proportion of primitive man, thus retaining a balance in numbers which prevented the extermination of the animal life on which man preyed.

With the acceleration of modern civilization the powers of man to exterminate the wild life about him have increased marvelously, with the modern improvement of weapons and means of locomotion, which have been accompanied by the taking over of enormous areas of forests and plains for agricultural purposes. This has been accompanied by rapidly increasing populations and with an amazing increase in the number of hunters which go afield each year making a total annual bag of extraordinary proportions.

As a result of an inquiry of the state game wardens throughout the country it appears that in 1921 hunting licenses were issued to more than 4,000,000 hunters, while in many states landowners may hunt without a license. This with the number hunting in a few states which do not require licenses will undoubtedly increase the number of hunters who went afield in that year to exceed 6,000,000. The fact that any game survives after the hunting season in which such an army goes forth to shoot is amazing.

The main danger to wild life, however, has not been from hunting for sport or for individual use, but has been largely due to the commercial use of game, and its extermination to make way for the occupation of its territory by man. The commercial pursuit of game and other mammals for one purpose or another has made use of many improved methods of killing and transportation, until to-day the urgent need of limitations to such destruction of our wildlife asset is obvious. Attempts to conserve our wild game by the prohibition of its sale for commercial purposes, the establishment of bag limits and of closed seasons, and other legal methods, have been effective in delaying extermination. Public education as to the needs of a reasonable use of our wild life is also becoming more and more widespread.

As an instance of the demands of commerce for wildlife products may be cited the rise in value of muskrat skins until in 1920 they sold in Montreal at \$7.50 each. The result of such prices was that muskrats were practically exterminated over great areas. Similar high prices for furs and an insistent commercial demand for them will menace the existence of all fur bearers not effectively protected by law.

In some areas, as in the State of Pennsylvania, an enormous amount of game is killed each year owing to the establishment of a considerable number of state game sanctuaries which serve as breeding grounds as well as refuges. Doctor Nelson believes that this is significant in indicating possibly a practical solution of the problem of wildlife conservation to the degree which the occupation of the states as a whole by man can permit.

For some years, he stated, the Biological Survey, with the United States Forest Service, has been working with the stock growers' associations of the West to bring about some agreed-upon policy for the conservation of game on the national forests, where vast numbers of domestic stocks are grazed. Many stockmen have taken the attitude that game is a nuisance since it takes some of the forage which stock might use. In addition, many stockmen have feared that game conservationists might desire to crowd domestic stock off the ranges in order to devote them to game. He believed that the movement among the stock growers was beginning to make headway, since at the last meeting of the National Stock Growers' Association, in Colorado, a resolution was passed recommending that study of game conditions on the national forests be made in order to work out a policy whereby game might be maintained along with the live stock. This is an extremely encouraging development.

Doctor Nelson agreed with Doctor Hornaday that the conservation element is a small minority and that they must keep everlastingly at the problem if they are to succeed. Discouraging reports of frightful slaughter are continually coming and these are not helpful to the morale of the conservation element. Indians have considered it their special privilege to kill wild game at will. He believes this source of destruction is a special danger which it is peculiarly difficult to avert in Alaska and northern Canada.

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